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Using a contingent valuation approach for improved solid waste management facility: Evidence from Kuala Lumpur, Malaysia

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ABSTRACT

This study employed contingent valuation method to estimate the willingness to pay (WTP) of the households to improve the waste collection system in Kuala Lumpur, Malaysia. The objective of this study is to evaluate how household WTP changes when recycling and waste separation at source is made mandatory. The methodology consisted of asking people directly about their WTP for an additional waste collection service charge to cover the costs of a new waste management project. The new waste management project consisted of two versions: version A (recycling and waste separation is mandatory) and version B (recycling and waste separation is not mandatory). The households declined their WTP for version A when they were asked to separate the waste at source although all the facilities would be given to them for waste separation. The result of this study indicates that the households were not conscious about the benefits of recycling and waste separation. Concerted efforts should be taken to raise environmental consciousness of the households through education and more publicity regarding waste separation, reducing and recycling.

1. Introduction

Rapid population growth, urbanization, industrialization and economic development have resulted in the generation of an enormous volume of solid waste in residential areas throughout the world but particularly in the rapidly growing cities of the developing world. Improper solid waste management in these cities is impairing human health and causing economic, environmental and biological losses (Moghadam et al., 2009) and is rendering the local authorities of these cities a daunting task (Damghani et al., 2008). As a consequence, the management of solid waste continues to be a major challenge (Foo, 1997). The contingent valuation method (CVM) has been the most commonly used non-market valuation method for estimating the benefits of environmental goods and services as it can create hypothetical markets that can be used to elicit people's willingness to pay (WTP) for changes in non-market goods, and in so doing, can be used to establish the benefits (Mitchell and Carson, 1989; Bishop and Romano, 1998; Carson et al., 2001). CVM is widely used all over the world in areas of economics such as in health economics (O'Shea et al., 2008; Borghi and Jan, 2008), cultural economics (Kim et al., 2007) and transportation safety and economics (Nor and Yusuff, 2003) as well as in environmental economics.

There is no direct market behavior through which economists can gather information about environmental benefits such as the benefits of waste management improvements. As suggested by NOAA (North Ocean Atlantic Association), CVM studies convey useful information for damage assessment including lost passive use values (Carson et al., 2003). In recent years, CVM has been extensively used in both developed and developing countries for valuation of a wide range of environmental goods and services (Whittington, 2002). CVM has thus emerged as the most direct and straightforward technique for evaluating public opinion on these topics, including the WTP to maintain or expand current programs. The drawback of the method is that responses are based on hypothetical situation rather than actual behavior. In the present study, CVM was employed to estimate the WTP of the households to improve the waste collection system in Kuala Lumpur, Malaysia.

1.1. Background of the study

Malaysia, with an area of 329,847 sq. km, had a population of approximately 25.7 million in 2009, with a per-capita GDP of $14,400 (World Fact Book, 2009). In Peninsular Malaysia (West Malaysia), the daily generation of waste escalated from 13,000 tonnes in 1996 to 19,100 tonnes in 2006 (Agamuthu, 2006, 1997). The urban population, which constitutes more than 65% of the total population, is the main waste generator. Table 1 shows the trends of waste generation in major residential areas in Peninsular Malaysia from 1970 to 2006. The table shows that Kuala

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Table 1
Generation of municipal solid waste in major residential areas in Peninsular Malaysia (1970–2006). *Source:* Agamuthu et al. (2009).

Urban centre Solid waste generated (tonnes/day)	1970	1980	1990	2002	2006
Kuala Lumpur	98.9	310.5	586	2754	3100
Johor Bharu (Johor)	41.1	199.6	174.8	215	242
Ipoh (Perak)	22.5	82.7	162.2	208	234
Georgetown (P. Pinang)	53.4	83	137.2	221	249
Klang (Selangor)	18	56	122.8	478	538
Kuala Terengganu (Terengganu)	8.7	61.8	121	137	154
Kota Bharu (Kelantan)	9.1	156.5	102.9	129.5	146
Kuantan (Pahang)	7.1	45	85.3	174	196
Seremban (N. Sembilan)	13.4	45.1	85.2	165	186
Melaka	14.4	29.1	46.8	562	632

Lumpur generates the highest waste among the major residential areas in Peninsular Malaysia. In Kuala Lumpur waste is increasing at a tremendous increasing rate. This is due in particular, to the rapid development of residential areas, rural–urban migration, increase in per-capita income, and the change in consumption patterns brought about by development. Apart from a voluntary and unsystematic process of extracting a proportion of recyclable items from the main waste flow, all waste is simply disposed of in landfills. At present, approximately 95–97% of waste collected is taken to landfill sites for disposal, with only a negligible proportion of the waste being subject to intermediate treatment. The remaining waste is sent for treatment at small incineration plants; diverted to recyclers and reprocessors; or dumped illegally. The economic, social and environmental benefits from waste separation and recycling are enormous (Begum et al., 2006; Massoud et al., 2003; SKM, 2003) and they have been emerged as the favored methods of solid waste management in many countries (Aye and Widjaya, 2006). Since 1993 a major effort of recycling was launched in Malaysia by the Ministry of Housing and Local Government but unfortunately limited recycling activities taken place (Agamuthu, 2001). The Malaysian's attitude towards recycling is higher, but only few practice it (Mamat and Chong, 2007). A survey carried out in 1999 showed that 59% of households were moderately aware with some basic knowledge and were mildly alert to solid waste issues (Irra, 1999). Furthermore, with an increasing population and horizontal expansion of the city, it has become very difficult to find adequate waste disposal sites for the future. Landfill capacity is severely limited in Malaysia and expansion of efficient, sanitary landfills, extremely problematic. Other difficulties relate to existing, short-term contractual arrangements; absence of support for recycling mechanisms at the community level and limited land availability for transfer stations and landfill sites make waste management vulnerable to the households of Kuala Lumpur.

The privatization of urban solid waste management in Malaysia was initiated in 1993 with the objective of providing an integrated, effective, efficient, and technologically advanced solid waste management system. Currently, households in the privatized areas are required to place their waste bags in waste bins in front of their houses (kerbsides) and private collectors collect the wastes twice or thrice a week. Payment for the collection services is the property tax is set by service providers with local authorities and currently paid as a share of "annual house assessment". Assessment is a form of property tax collected by the local authorities for the provision of services to the residents. The amount and classification of properties varies from one local authority to another. In most states, the amount of assessment tax is calculated based on certain percentage of annual value of the property. The annual value of a property is the total value of rents if the property is rented out in the open market.

To date there have been few studies conducted to estimate consumer WTP for improved solid waste management system for the area of Kuala Lumpur and Petaling Jaya using CVM (Mourato, 1999; Jamal and Noor, 2001; Othman, 2002). However, no study to investigate the effect of waste separation on the WTP of the households has yet been undertaken. Given the above background, this study demonstrates the importance of WTP in determining the success of a waste collection project to provide this information for Kuala Lumpur. This study conducted an economic study of the household demand for improving municipal solid waste management. Specifically, how the WTP of the households differs when waste separation at source is made mandatory and evaluated the awareness, perception and attitudes of the households towards improving waste management system of Kuala Lumpur.

2. Methodology

2.1. Empirical design and data collection

The questionnaire used in this study was based on focus group discussions among the members, students of the Faculty of Economics and Management Science, International Islamic University Malaysia. We then conducted a pretest on 10 residents in Kuala Lumpur in order to uncover any misinterpretation of the questions and to identify the bid vector that should be used in the final study, which we carried out with a double bounded elicitation format. The bid vector was selected by accounting for the results of the pretest and using procedures reported in the literature (Cooper, 1993; Alberini, 1995; Hanemann and Kanninen, 1998).

2.2. Survey design and sampling method

We employed direct face-to-face interviews in this study because this has been shown to be the most reliable approach in contingent valuation studies (Carson et al., 1996). The survey was conducted in October 2009. We decided to confine the survey within Kuala Lumpur city because its residents are the immediate beneficiaries of the waste collection systems that have been introduced by DBKL(Dewan Bandaraya Kuala Lumpur). DBKL is a local authority which administrates Kuala Lumpur city centre and other areas in the Federal Territory of Kuala Lumpur. This agency is under Federal Territories Ministry of Malaysia. DBKL are responsible for public health and sanitation, waste removal and management, town projecting, environmental protection and building control, social and economic development and general maintenance functions of urban infrastructure.

Another consideration was whether the valuation data should be collected for households (Carson et al., 1992; McConell, 1995) or on an individual basis (Kealy et al., 1990; Imber et al., 1993). Wilks (1990) points out that this decision depends upon the type of payment vehicle that is selected and whether such payments are usually made on a household or individual basis. The payment vehicle chosen in the present study was an increase in the waste collection service charge and because waste is collected and paid for at the household level, we chose the household as the unit of analysis. Given this choice, we chose as our reference income the household income rather that the individual respondent's income. We have selected few residential areas from Kuala Lumpur as our study area. They are Bandar Tasik Selatan, Setapak, Wangsa Maju, Ampang and Titiwangsa.

2.3. Design of the questionnaire

The questionnaire had three sections. The first section included questions relating to the perception, attitudes and awareness of

the households towards the environment and towards waste management in general. The second part included a description of the current situation regarding waste collection and disposal, existing problems and stakes of the current waste management program, the contingent choices/market about a new hypothetical solid waste management program and the payment methods were included in the second part. The third section collected information on the households' socio-economic characteristics. The attributes of the choice task were based on the focus group discussions and pretest studies. The resulting attributes that were used in our study are

- a change of collection frequency from 3 times weekly and irregular (baseline) to 3–4 times weekly;
- a change in disposal method from control tipping to sanitary landfill;
- a change in the use of transportation from a mix of conventional open trucks and compactor to only covered trucks and compactor;
- the provision of free facilities and multiple containers for every household to facilitate mandatory recycling or waste separation at source.

Before the CVM questions were presented to the households, there was a description of the current waste management project in terms of the selected attributes and its implication on the environment and how they have been paying for the waste services. The improved waste management project was then presented. The households who opted for the current management project were not asked any WTP question. The households who decided to vote for the improved project, they were asked to reveal their WTP (dichotomous choice method) to obtain the improvement. The improvement project consists of two versions with the following service features.

Version A

- Collection frequency: regular: 3–4 times weekly.
- Separation of wastes at source: mandatory and waste separation facilities and multiple containers provided free.
- Type of waste disposal method: sanitary.
- Mode of transportation: covered or compactor tracks.

Version B

- Collection frequency: regular: 3–4 times weekly.
- Separation of waste at source: not mandatory and free containers for recycling not provided.
- Type of waste disposal method: sanitary.
- Mode of transportation: covered or compactor trucks.

Note that the improved project differs in terms of whether or not waste separation or recycling is made mandatory. The households were told explicitly that if they decided to vote for the improved project, they would need to pay the monthly waste charges directly to the service provider, just the way they did for other utilities such as telephone lines and electricity. A double bounded dichotomous question was used in this study, that is, a dichotomous choice question was followed by a question for a second price that involved a substantially larger or smaller amount. A vector composed of four prices was chosen for the implementation of the dichotomous choice format. Each individual randomly received one of these prices. The amounts for the first bid vectors were MYR 10, 15, 25 and 35 (1 USD approximately MYR 3.19). If the households gave a positive answer, they were asked if they would be willing to pay a higher amount chosen from among bids of MYR 15, 25, 35 and 50. If the answer to the first question was negative, then the second bid vector was lowered to MYR 5, 10, 15 and 25.

It is an important objective of this study to understand how household WTP changes when recycling and waste separation at source are made mandatory. However, as payment for waste charges will not be made on a "pay per bag" or any unit-based pricing scheme, the households are expected to display strategic behavior to support any recycling facility but may not actually recycle their wastes in practice. In order to capture the variation of WTP estimates, we will administer two sets of CVM questionnaire on separate samples. Version A considers all improvements in the attributes while version B considers all improvements except that recycling will not be made mandatory and there will be no provisions of facilities or containers for recycling or waste separation. The payment vehicle will be direct monthly payment to the service providers. For the study about 500 households from five residential areas (Bandar Tasik Selatan, Setapak, Wangsa Maju, Ampang and Titiwangsa) from Kuala Lumpur were sampled. Each version of the contingent valuation had 50 households for each of the urban area. These residential areas are chosen because they are located at the centre of Kuala Lumpur. Among them, Wangsa Maju, Ampang and Bandar Tasik Selatan have become the largest townships in Kuala Lumpur and they have various housing areas. These residential areas are very crowded and are considered to generate enormous amount of waste.

2.4. Waste management valuation questionnaire

In the dichotomous choice format, households were confronted with only a single bid; therefore a further subdivision of the samples is necessary. After we described the status of waste management in study area and the proposed new improved waste management and recycling project, the households were asked the following valuation question:

> Obviously the implementation of this program will incur a cost, which would be directly or indirectly paid by us. The government will finance this program through an increase in the waste collection service charge, which will increase your family expenditures. Considering your household's income and expenditure, would you be willing to pay this increased cost so that the government can implement this program? Remember that this will leave you less money for, for example, food, clothing, shoes, travel car use and savings.

Households, who answered yes, were then asked the WTP question:

> Are you willing to pay the waste collection service charge so that the government can implement this program?

The households who were not willing to pay were asked a follow-up question to establish their reasons for not wanting to pay. The households were randomly divided into the bid level, which was taken from pilot survey.

3. Results and discussion

3.1. Socio-economic characteristics of the households

In this study, After eliminating responses with missing or inconsistent answers to the valuation questions, 467 responses (93.3%) were valid for the residential areas in Kuala Lumpur. Table 2 reports the descriptive statistics of the main socio-economic characteristics of the households. The selected samples were representative of the population of the entire country. The gender distribution in the

Table 2
Descriptive statistics of socio-economic characteristics of the households.

Item	No. of households	Percentage
Gender		
Male	226	48.4
Female	241	51.6
Age		
18–24	33	7
24–35	135	29
>35	299	64
Race		
Malay	196	42
Chinese	159	34
Indian	70	15
Others	42	9
Education		
University	157	33.7
Diploma and certificate	141	30.2
SPM/SPVM	89	19.1
STPM	26	5.7
SRP/PMR	22	4.8
Primary	20	4.4
No. formal education	11	2.1
Occupation		
Full time employed	301	64.5
Self employed	50	10.8
Part time	49	10.5
Students	38	8.1
House wives	14	3.1
Unemployed	8	1.7
Retired	7	1.3
Income		
<RM1000	102	22
RM1000 up to RM3000	163	35
RM3000 up to RM10,000	118	25.2
>RM10,000	83	17.8

samples was 48.4% male and 51.6% female. Malaysia's population (2001 Census) growth is at 1.723 and sex ratio is 1.069 male to 1 female (CIA, 2010).The average age was just 40, with the lowest being 19 and the highest 66 years old. We consider the age group 18–24 as youngest group, the age group 24–35 as middle age group and the age group over 35 as the older group. In this study it has been found that 7% of the households are young, 29% are middle age and 64% of the households are over 35 years old. The average household size is 4, maximum is 10 and minimum number is 2. In this survey, 42% of the households were Malays, 34% were Chinese, 15% were Indian and 9% were others. The percentage of Malay population in Kuala Lumpur alone was around 38% in 2000 while the Chinese population comprised 43% and Indians 10% (Wikipedia, 2010). The highest percentage of the households was married (58%) followed by 29% singles, 7% widows and 6% divorced or separated. The highest percentage of the households had university degree (33.7%), 30.2% had diploma and certificates, 19.1% had reached SPM/SPVM levels, 5.7% had reached STPM levels, 4.8% had reached SRP or PMR levels, 4.4% had reached primary level and 2.1% had no formal education. Malaysia's literacy population is 88.7% while 97.5% in Kuala Lumpur (Wikipedia, 2010). Most of the households (64.5%) were full time employed. The corresponding 10.8% were self-employed, 10.5% were employed part time, 8.1% were students, 3.1% were housewives, 1.7% was unemployed and 1.3% was retired. The highest percentage of the households (35%) had an income range of RM1000 up to RM3000 per month. while 22% of the households have income range of less than RM1000 per month. There were only 25.2% households with an income range of RM3000 up to RM10,000 and the remaining 17.8% of the households had an income range of more than RM10,000 per month. According to the Department of Statistics Malaysia, more than half of the Malaysian households earn a monthly income of less than RM3000. The remaining of the households earn between RM3001 and RM4000 (12.9%), RM4001 and RM5000 (8.6%), RM5,001 and RM10,000 (15.8%), and above RM10,000 (4.9%) (Department of Statistics, 2009).

3.2. Attitudes of the households towards the environment and waste management

The households were asked to rank the importance of the various socio-economic sectors for government budgetary allocation. Table 3 presents the findings. The environment sector was one of the important areas, ranking fourth out of the seven sectors. The households were also asked about their interest in environmental problems. It has been found that 28% were very concerned about environmental problems. Then they were asked to rank eight specific environmental problems. Solid waste issues were ranked in great importance (fourth out of eight). This suggests that they consider solid waste management as of great importance to them. We also asked how many bags of waste each household produced, on average per 3–4 days. Most households (42%) produced 3–4 waste bags on average 3–4 days (Table 4). So, they produced on average one bag of waste per day and 30 bags of waste per month. A typical waste bag contained around 1 kg of waste. Waste generation in the study area averaged 30 kg/month for each household. As the number of persons per household averaged four, per-capita waste generation thus averaged around 0.25 kg/day, which is similar to the findings of Saeed et al. (2009). In terms of who normally collected the wastes for disposal and delivered them to the collectors, most of the work was done by the wife (Table 5).

3.3. Knowledge and awareness of solid waste and recycling

The Table 6 shows that most of the households have knowledge of solid waste management (88%). Among them, 24% obtained their

Table 3
Importance of sectors for government funding and ranking of environmental problems.

Sectors	Mean score	Ranking
Importance of sectors for government funding		
Public education	2.0	7
The natural environment	3.7	4
Crime prevention	3.2	6
Housing	3.9	2
Poverty or unemployment	3.3	5
Public health services	3.8	3
Defense	5.6	1
Importance of environmental problems		
Water pollution	2.2	8
Air pollution	2.9	7
Deforestation activities	3.6	6
Land erosion	5.7	3
Noise pollution	5.8	2
Solid waste dumping	5.4	4
Extinction of animals and plants	6.6	1
Food safety due to overuse of chemicals	4.1	5

Table 4
Packages of waste on average 3–4 days.

Packages of wastes	No. of households	Percentage
1–2 packages	93	20
3–4 packages	196	42
5–6 packages	84	18
7–9 packages	65	14
More than 10	29	6
Total	467	100

Table 5
Normally who does the collecting and placing of wastes for disposal?

Members	Number of households	Percentage
Husband/father	11	2.4
Wife/mother	360	77.2
Child	24	5.2
Maid	72	14.2
Total	467	100

Table 6
Comparison of positive WTP, valid zero WTP and rejection of contingent market.

Comparison of positive WTP, valid zero WTP and rejection of contingent market	Number of households	Percentage
Positive WTP	328	70.3
Valid zero WTP	29	6.3
• Have no extra income but otherwise would contribute	17	3.7
• Don't believe that the waste management improvement programs would bring the changes	12	2.6
Rejection of contingent market	110	20.9
• It is the government's responsibility	72	15.4
• Waste management improvement is not important	9	2.01
• It is the responsibility of those who pollute the environment to pay for it	29	3.49

knowledge from newspapers and 26% from TV (Table 6). More households knew about waste recycling and although most learned about waste recycling on newspaper and TV. The households who reported a WTP value greater than zero were treated as having a positive WTP. The households who reported a zero WTP were asked a follow-up question to establish their reasons for not willing to pay. The households who answered "have no extra income but otherwise would contribute" and "don't believe that the waste management improvement programs would bring the desired changes" were treated as having a valid zero WTP. The households who answered that "It is the government's responsibility", "Waste management improvement is not important" and "it is the responsibility of those who pollute the environment to pay for it" were treated as having rejected the contingent market. Table 7 summarizes the WTP values of the households in these categories. We found that 70.3% of the households reported a positive WTP to improve the waste management services in Kuala Lumpur. Of those who were not willing to pay, only 6.3% were counted as valid zero responses.

Of these, 3.7% lacked sufficient extra income and 2.6% did not believe that the waste management program would bring the desired changes. Those who rejected the contingent market mostly did so because they felt that it was the government's responsibility to improve the waste management services. Table 8 summarizes the frequency of the responses to the dichotomous choice question. It has been found that the frequency of no/no responses increases and that of yes/yes responses decreases as the WTP value increases.

Table 7
Knowledge and awareness of solid waste and recycling.

	Number of households	Percentage
Yes	410	88
No	57	12
Total	467	100
Source of knowledge		
Information from newspaper	98	24
Information from Radio	16	4
Information from TV	106	26
Information from all the mentioned sources	190	46
Total	410	100

3.4. Empirical model of willingness to pay for improved solid waste management and socio-economic factors

This study examines the factors which affect the willingness to pay of the households for improved waste management using binary choice modeling (logit model). The Maximum Likelihood (ML) method was employed to estimate the parameters in logistic regression model. The likelihood ratio index has been measured as an indicator of goodness of fit for the logistic regression model. As such, the model assesses the relationship between various factors and the households' willingness to pay for improved waste management. The dependent variable is designed as a dichotomous dummy because of assuming whether the respondent is willing to pay or not.

The model is as,

$$\text{Log } P_i/(1-P_i) = Z_i = \beta_0 + \beta_i X_i + e$$

where,

$P_i = 1$ if the respondent is willing to pay for improved waste management;

$P_i = 0$ for otherwise;

X_i = independent variables;

β_0 = constant term;

β_i = coefficient of independent variables;

e = the error or disturbance term;

$i = 1,2,3,\ldots,n$.

The independent variables of this model are age, number of family members, education, income and conscious about solid waste management. Most of the variables are derived from the survey, in which it is considered relevant from theoretical point of view and included as independent variables.

3.5. Estimation results from double bounded dichotomous choice

In this method, the individual is presented with a first bid (BID1) and asked whether she or he would pay this price for the new waste management program when thinking about her or his maximum subjective value. If the answer is yes, then a second higher bid (BIDU) is presented. If the answer is no, then a lower second bid (BIDL) is presented. The respondent then chooses between two alternatives: an improved state with three potential costs (BID1, BIDU and BIDL) that derive a utility U1, and the status quo U0 yielding no improvement in environmental conditions and no increase in cost. Four possible outcomes arise with different probabilities of: (i) both answers are 'yes'; (ii) a 'yes' followed by a 'no'; (iii) a 'no' followed by a 'yes'; and (iv) both answers are 'no'. Assuming that each random term is distributed as a Type I extreme value, then following Hanemann (1991), the following response probabilities are obtained for our model:

$$p(Yes-yes) = P_n(YY) = 1 - \frac{1}{1+e^{(\alpha+\beta BID_u+\Sigma_\gamma Z_n)}}$$

$$p(Yes-no) = P_n(YN) = \frac{1}{1+e^{(\alpha+\beta BID_{U'}+\Sigma_\gamma Z_n)}} - \frac{1}{1+e^{(\alpha+\beta BID_1+\Sigma_\gamma Z_n)}}$$

$$p(No-yes) = P_n(NY) = \frac{1}{1+e^{(\alpha+\beta BID_1+\Sigma_\gamma Z_n)}} - \frac{1}{1+e^{(\alpha+\beta BID_L+\Sigma_\gamma Z_n)}}$$

$$p(No-yes) = P_n(NY) = 1 - \frac{1}{1+e^{(\alpha+\beta BID_L+\Sigma_\gamma Z_n)}}$$

Table 8
Frequencies of answer of WTP.

Version	WTP	No/no	No/yes	Yes/no	Yes/yes	Total
A	WTP interval frequency	0–5	5–10	10–15	>15	118
B	WTP interval frequency	0–10	10–15	15–25	>25	90
C	WTP interval frequency	0–15	15–25	25–35	>35	76
D	WTP interval frequency	0–25	25–35	35–50	>50	44
Total		50.4% (165)	15.7% (51)	22.6% (74)	11.3% (38)	328

Table 9
Variables included in the logit model.

Variables	Definition	Average (standard deviation)
Dependent variable		
Willingness to pay	Dummy to represent willingness to pay '1' and not willingness to pay '0'	0.7 (0.4)
Independent variables		
Gender	Dummy to represent male '1' and female '0'	0.6 (0.3)
Age	In years	39.5 (9.3)
Family members	Numbers	4.6 (1.2)
Income	Household monthly income (1000 RM[a]/month)	3.5 (1.4)
Consciousness about waste management	Dummy to represent conscious about waste management '1' and not conscious about waste management '0'	0.6 (0.3)
Satisfaction on waste collection services	Dummy to represent satisfied '1' and not satisfied '0'	0.17 (0.3)
Agree to separate	Dummy to represent agree '1' and not agree '0'	0.4
Bid (WTP value)	waste collection service charge (RM/month)	14.1 (0.6)

[a] 1 USD = MYR 3.19.

where BID_1 is the initial bid; BID_U is the higher bid; BID_L is the lower bid; α, β and γ are parameters and Z is the socio-economic characteristics of the respondent n being analyzed. For the dichotomous choice question, a double bounded logit model was used in this study. The independent variables used in the double bounded logit analysis and their basic statistics are given in Table 9.

All estimates performed in this study used the Econometric package Limdep Nlogit 8.0 (Greene, 2002). The estimation results for the parameters are shown in Table 10. In this analysis, valid zero WTP responses and responses that rejected the contingent market were dropped from the data set as is usually done in CVM studies. The mean WTP was calculated using the estimated coefficients. Overall, the model depicts a satisfactory goodness of fit with Mc-Fadden R^2 value of 0.15.

The signs for all coefficients were consistent with our intuition. In this study, age, education, income, and concern about waste management were expectedly positive and highly significant, as we expected. The negative coefficient for age ($P < .01$) indicated that holding all other variables constant, older people are not willing to pay more than younger people. This suggests that older people in Malaysia are more resistant to changing their ways of doing things around the house, and since waste separation and recycling may be considered relatively new solid waste management practices, the households with older household's leaders are less likely to engage in waste management. Or even they think that of they will pay more for a new management system, perhaps the expected improvement would not take place without the intervention of a regulatory body that can regulate the activities of the private companies acting in the waste management sector. This leads them to pay less for the waste management improvement. This result is consisted with some other studies (Afroz et al., 2006; Afroz and Keisuke, 2009). The positive coefficients for education ($P < .01$) and income variables suggest that holding all other variables constant, educated and wealthier people are willing to pay more that less-educated and lower-income people. This result seems reasonable since a higher level of education and income could be related to a better understanding of the problem and greater ability to pay. The positive relationship between these two variables is generally supported by the WTP literature. For example, income and education had a positive effect on WTP in several studies (Jin et al., 2006; Basli et al., 2006; Caplan et al., 2002). However, the number of members in the house hold was unexpectedly not found to affect WTP levels significantly in our study, although it does have a positive sign, which is similar with the results of some previous studies (Othman, 2002; Jin et al., 2006). As might be expected, the coefficient for the attitudinal variable for concern about waste management is positive and but statistically insignificant, which supports the hypothesis that the households who are more concerned about the solid waste management in Malaysia would have more WTP for the new solid waste management program. The positive sign for concern about waste management is supported by the results of the study conducted by Jin et al. (2006). The positive coefficient for satisfaction is significant ($P < 0.01$). This means that the households who were more satisfied with waste collection services were willing to pay more than dissatisfied households. This is reasonable since the WTP of the households has been shown to depend on their

Table 10
Factors affecting the willingness to pay of the households.

Variables	Estimation	Standard error	*t*-Statistics
Gender	−2.00	1.57	−1.31
Age	−0.09	0.01	−1.73*
Family member	0.09	0.33	0.26
Education	2.01	0.91	2.20**
Income	0.53	0.22	2.44***
Concern about waste management	1.90	0.78	4.32***
Satisfaction on waste collection services	0.90	0.78	1.11
Agree to separate	0.40	0.81	0.58
Bid	−1.12	0.01	−11.32***

* Significant at $p \leqslant 0.10$.
** Significant at $P \leqslant 0.05$.
*** Significant at $P \leqslant 0.01$.

Table 11
WTP Statistics under version A and B.

Area	Version A (waste separation at source mandatory)		Version B (waste separation at source not mandatory)	
	Number of responses	Mean (RM)	Number of responses	Mean (RM)
Bandar Tasik Selatan	30	20	30	22
Setapak	28	19	29	20
Wangsa Maju	32	18	39	23
Titiwangsa	33	21	42	24
Ampang	23	22	42	26
Overall	146	20	182	23

satisfaction with the waste collection service provided by the waste collectors (Kassim and Ali, 2006). The positive coefficient for agree to separate wastes was also significant ($P < 0.01$). This means that the households who agree to separate the waste at their house are willing to pay more. This result indicates that Kuala Lumpur residents have a positive WTP for the new solid waste management program, which includes a waste minimization and recycling option. This is a welcome development in the progress towards a sustainable solid waste management program. The value of the LR statistics ($P < 0.00001$) shows that all the variables have a significant effect on the WTP of the households.

The study shows that of the 500 households surveyed, 328 households are willing to pay while 139 households are not willing to pay. Hence there was a total of 467 valid households. All other households (33) simply opted for the baseline waste services. An investigation of the WTP statistics for the five residential areas in Kuala Lumpur reveal that mean WTP were much higher for the version B which does not require mandatory waste separation at source (see Table 11). For the entire samples, the overall mean WTP for version A is MYR20 (USD 6.26) and for version B is MYR23 (USD 7.21), respectively. Among the residential areas the mean WTP is the highest in Ampang.This difference might be due to the highest mean monthly income for Ampang households (MYR 4012) (USD 1257) compared to MYR 3034 for Bandar Tasik Selaton, RM 2989 for Setapak, 3870 for Wangsa Maju and 3912 for Titiwangsa. A comparison with respect to the WTP findings was made with that of the Brunei study (Kwabena and Rashidah, 2001). The study, using iterative bidding CVM, found that average maximum monthly WTP for all rural households that used free government-operated community waste collection centres was B$ 12.64 (MYR 27) (USD 7.18). The WTP estimates found in that study was comparable to that of our study.

The results of our study suggest that while in version A, households are asked to separate the waste at source with the facility of container and recycling, they declined their WTP for version A. This shows that the offer of free containers for waste recycling did not influence the households to behave strategically to reveal a higher WTP – for instance, the households have all the incentives to overstate their WTP to obtain the said recycling facilities/containers but may not actually conduct recycling in practice if they presume that the mandatory ruling for separation at source is not enforceable.

3.6. Marginal willingness to pay

In this study, we simply elicited the households' maximum WTP for the improvement of the current waste collection services. After responding to the dichotomous choice question, we asked the households the following specific CV question:

> What would be the maximum amount that you would be willing to pay each month for the amount of wastes that your household currently generates? MYR. . . . . .

Although, the answer to this question, would provide incentive compatible responses to the households in the sense that a household's WTP potentially correlates with the amount of wastes being generated (bags per month), we hypothesized that there would be an inverse relationship between the average WTP per bag and actual generation of wastes by the household. The average WTP was thus presumed to represent the cost level per bag and information on household WTP based on the answers to this question versus the number of bags of waste produced monthly could be used to generate an equation that reflects household demand (i.e. a WTP curve for waste disposal).

Here, we assumed that household generation of solid waste is influenced only by the disposal cost per bag of waste, for which we used the average WTP per bag as a proxy. Thus, we estimated the household demand function for waste disposal by regressing the amount of wastes generated against the calculated household average WTP per bag of wastes using the model of Othman (2002). The double-log specification was used, That is:

$$WBAGS = E^{A}\ (AWTP^{\beta_1})$$

Or

$$Ln\ WBAGS = A + \beta_1 Ln\ (AWTP)$$

where *Ln WBAGS* = natural log of the amount of waste generation (number of bags of waste per month), *Ln AWTP* = natural log of average WTP per bag (monthly WTP/number of waste bags generated per month). We obtained the following regression results:

$$Ln\ WBGS = 1.21(0.03)^{***} - 0.2LnWTP(0.02)^{***}$$

Values in parentheses represent the *t*-statistic; triple asterisks denote significance at ($P < 0.01$). Adjusted $R^2 = 0.48$; Durbin Watson statistics = 1.22; and condition index = 1.

These results show a strong inverse correlations between the level of waste generation and the average WTP per bag which is similar to the results of Othman (2002). The mean monthly WTP calculated from the survey data was RM 22 (USD 6.7) per household. In the next section, we will estimate the household demand (WTP) curve for waste disposal based on the results of this regression.

3.7. Calculation of the WTP curve for waste disposal

The above regression equation can be rewritten as:

$$WBAGS = exp^{1.89} AWTP^{-0.45}$$

Using this equation, the number of waste bags an average household will be willing to produce per month at a given cost per waste bag can be projected (Table 12)

The mean number of waste bags generated monthly can be calculated from the sample data; as we reported earlier, this equals 42 kg/month per household. Therefore, the mean AWTP from the

Table 12
Estimates of households' wastes generation under varying charge levels.

Waste charge (MYR) per bag	Number of bags of wastes monthly
0.1	38
0.5	17
1.0	12
1.5	10
2.0	9
2.5	8
4.0	6
5.0	5
10.0	4

sample data is MYR 0.52 (USD 0.16) This is derived by dividing the average WTP of MYR 22 (USD 6.89) with 42 kg/month which is the average quantity (equivalent to 38 bags) of waste generated monthly per household. The above model predicts the sample averages in Table 12 quite well, as depicted by Table 12. The overall estimates show that waste generation declines at a decreasing rate for successive increases in the waste cost per bag; that is, $\sigma^2 WBAGS/\sigma AWTP^2 < 0$. This suggests that the households' marginal WTP also declines for each additional unit of waste being generated $\sigma^2 AWTP/\sigma WBAGS^2 < 0$. This result is similar to those in previous studies (Linderhof et al., 2001; Dijkgraaf and Gradus, 2003) which also estimated that bag based pricing of waste collection system reduces the waste generation. However, a bag based pricing system may lead to illegal dumping. In this situation, Fullerton and Kinnaman (1996) stated that if the social valuation of illegal dumping is in line with the costs of collecting and treating solid waste, the bag based pricing system is preferable. Furthermore, the administrative costs for bag based pricing are much lower than in other pricing systems such as weight-based, frequency-based and volume-based pricing (Dijkgraaf and Gradus, 2003). Any policy proposal that affects solid waste management in Kuala Lumpur must thus be comprehensive, integrated and incentive-compatible while still yielding the required environmental impacts. It is simple economics for households to participate in waste minimization schemes if there is ample room for optimizing behavior, such as the capacity of households to reduce their waste disposal costs by increasing their recycling activities. This would require the imposition of market-based instruments such as a "pay per bag" policy, a volumetric pricing scheme or a deposit-refunds system. Therefore, a mix of policy instruments such as economic incentives, the development of an adequate related infrastructure, and moral suasion are important to shape household behavior so that it becomes consistent with the waste minimization philosophy. The information on marginal WTP combined with knowledge of supply affordability (marginal cost) provides useful to guidance to help the service providers to determine a pricing framework and whether waste charges should be implemented on a "pay per bag" basis. In the economic sense, the optimal tariff rate is reached when the marginal social cost of provision (MSC) intersects with the demand curve (i.e. MSC = WTP). Should there be an improvement in the management project, such as those reported in previous CVM studies, an appropriate premium should be added to the estimated WTP to reflect the households' preferences for improved attributes.

4. Conclusion and policy implication

This research employed CVM to estimate the WTP of the households to improve the waste collection system of Kuala Lumpur. On average the households in Kuala Lumpur are willing to pay MYR 22 (USD 6.89) waste collection service charge per month. Here the average WTP has been calculated for the entire sample by averaging the two WTP of the two versions of improved solid waste management. This means that they are willing to share 1.7% of their income. Although this is very low comparing to other studies (Morrison et al., 1998; Altaf and Deshazo, 1996) but it is reasonable compare to the annual house assessment which they are paying.

The total number of households in Kuala Lumpur is 54000. So, the aggregate value of WTP of the households in Kuala Lumpur city is (22 X54000) or MYR 1.1 million (USD0.1 million). A key policy implication of the results of this study is that policy makers can choose from a set of scenarios, which includes different levels of attributes and WTP estimates for each attribute, to design an improved waste management project for Kuala Lumpur. Policymakers have to consider the investments required, the service outcomes (i.e. how good the waste collection services), and the amount households are willing to pay for improved services. In addition, policymakers need to be aware that socio-economic characteristics and quality of waste collection services will influence the willingness to pay for better waste management. Without knowing the costs of providing various service improvements, we cannot recommend specific improvement measures. What we can state with clarity, nonetheless, is that survey households express a clear preference for improvements in waste management services and a considerable willingness to pay for it.

This study also generated information on the marginal pricing for solid wastes by estimating the demand curve for disposal of bags of waste. The demand curve assesses the monthly waste generation by households under the current management regime given successive increases in the disposal cost per bag. It can be shown, for instance, that if the cost per bag is set at MYR 0.7 (USD 0.21) per bag, households will generate an average of 17 bags of waste versus 12 bags if the charge is increased to MYR 1.00 (USD 0.31). Thus, if the marginal social cost of supply (MSC) is known, the optimal cost per bag can be determined by the intersection between the MSC and demand curves. Any policy proposal that affects solid waste management in Kuala Lumpur must be comprehensive, integrated, and incentive-compatible while still yielding the required environmental impacts.

Households will participate in waste minimization schemes if they have room to exhibit optimizing behavior, such as reducing their waste disposal costs by increasing their recycling activities. This would require the imposition of market-based instruments such as "pay per bag" policy, a volumetric pricing scheme or a deposit-refunds system. Therefore, a mix of policy instruments such as economic incentives, the development of adequate related infrastructure, and moral suasion can shape households' behavior so that it becomes consistent with the waste minimization philosophy. The majority of the households (54%) were dissatisfied with the quality of the current waste collection services. This can be the basic problem to improve the waste management system in Kuala Lumpur. If the services of waste collection are not satisfactory for the households, how can they accept to pay more without knowing that the system will be improved? This suggests that it will be important to improve solid waste management services in the residential areas in Kuala Lumpur. In addition, the WTP for version A is low when waste separation is mandatory. This result indicates that the households in Kuala Lumpur are not getting enough information about the benefits of waste separation and recycling. In this study, it is also found that only 28% of the households are very concern about the environment. It is evident that concerted efforts to raise environmental consciousness through education and more publicity regarding waste separating, reducing and recycling could affect the households waste generation and recycling. The number of households are willing to separate their wastes is lower in Kuala Lumpur. This may also explain the lower WTP of the households in this area. The WTP of the households would increase if they received enough information about the benefits of waste separation and recycling and were encouraged to become involved in the proposed solid waste management program, with a better quality of collection services.

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